Optimal Edge Detection Method for Diagnosis of Abscess in Dental Radiograph

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***Abstract*-Dental image processing is use in case of human identification. Moving a step ahead in the area of image processing of dental radiograph for effective diagnosis and detection of problems in tooth. In this paper we present a new approach in the same area to detect and diagnose the dental abscess. A dental abscess is formed of pus affecting teeth or gums. It can cause throbbing pain and is caused by bacterial infection. Dental abscess are generally found at the root of tooth. In the proposed work enhancement of dental radiograph is done using pre processing techniques for removal of noise and later finding out the optimal edges. Based on the edges the severity and the area being affected is found for further diagnosis and treatment. In this paper the resultant images were also shown to the doctors and were found satisfactory according to them. Digital dental radiographs, in which enhancement is done automatically, are available but the system are very costly. The proposed algorithm will give alternate solution to this problem.**

Keywords- Lesion, Abscess, dentine, pulp, ISEF, dental radiograph, dentistry

I. INTRODUCTION

A dental abscess is formed of pus affecting teeth or gums. Dental abscess can cause throbbing pain and is caused by bacterial infection. A dental abscess can begin as a tooth infection or cavity. These infections are common in people with poor dental health and result from lack of regular dental care. Dental abscess are generally found at the root of tooth. The basic symptom of abscess is pain at that part of tooth which will be growing with time. The cause of these infections is direct growth of the bacteria from an existing cavity into the soft tissues and bones of the face and neck. An infected tooth that has not received appropriate dental care can cause a dental abscess to form. Poor oral hygiene, (such as not brushing and flossing properly or often enough) can cause cavities to form in teeth. The infection then may spread to the gums and adjacent areas and become a painful dental abscess.

Symptoms of a dental abscess typically include pain, swelling, and redness of the mouth and face. The signs of dental abscess typically include, but are not limited to, cavities, gum inflammation, oral swelling, tenderness with touch, pus drainage, and sometimes difficulty fully opening of mouth or swallowing. Successful treatment of a dental abscess centers on the reduction and elimination of the offending organisms. This can include treatment with antibiotics and drainage. If the tooth can be restored, root canal therapy can be performed. Non-restorable teeth must be extracted, followed by curettage of all apical soft tissue.

The objective of the paper is to develop a new algorithm for the detection of abscess for the available dental radiograph which is standardised and scientific tool to minimize the human error in the case of deciding the right treatment on the basis of visual perception in benefit of both doctor as well as patient.

II. PROBLEM DEFINITION

The raw data obtained directly from x-ray acquisition device may yield a comparatively poor image quality representation. In case of medical images human involvement and perception is of prime importance. It is a difficult task to interpret fine features in various contrast situations [5].

Nowadays digital dental radiographs, in which enhancement is done automatically, are available but the system are very costly. Our algorithm will give alternate solution to this problem.

As radiographic imaging study in medical practice [6],[7],[8]provides better clue for diagnosis, but it is not merely the final tool; as investigations must be co-related with clinical findings.

III. PROPOSED APPROCH

So targeting the problem in II we propose new approach for the detection of abscess form the dental radiograph

TABLE I: SUGGESTED TECHNIQUE

Sr.No.	Steps
1	Acquire digital dental images.
2	Convert image in to gray scale image.
3	Apply filtering operations for image enhancement.
4	Extraction of abscess from image.
5	Edge detection using ISEF (Infinite Symmetric Exponential Filter).
6	Detection and decision.

A. Image Enhancement

In peraipical view, as shown in figure 1, we classify three main classes of "objects"; teeth, gum, and air. An area with "bright" gray scales (except for the pulp tissue) consists tooth area while areas with "mid-range" gray scales consists gum area, and "dark" gray scales indicates air. For better segmentation,[11] it is desirable to convert poor quality dental radiograph in to considerable degree of contrast between the dominant gray scales used in capturing the different classes of objects.[7]

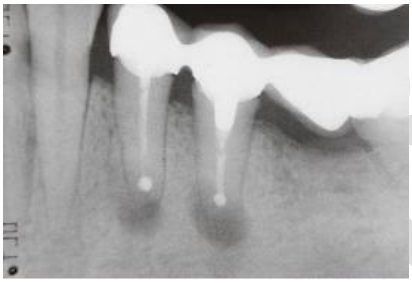

Figure 1: Dental Radiograph
{Courtesy: Dr. Ronak Panchal}

Median filters is applied on the image obtain after adaptive histogram equalization of original image to remove noise present in the image for further processing. Enhanced image is shown in figure 2.

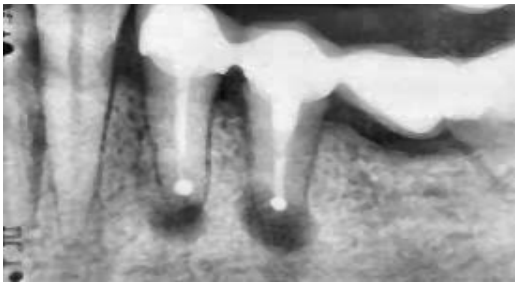

Figure 2: Enhanced Dental Radiograph

B. Abscess Extraction

We extract abscess from the dental radiograph, so that abscess affected area can be visible more properly as shown in figure 3.

Figure 3: Tooth Abscess

C. Edge Detection using ISEF [10]

Edge detection of abscess is done by ISEF (Infinite Symmetric Exponential Filter).

TABLE II: ISEF Algorithm

Sr.No	Steps
1	Apply ISEF Filter in X direction
2	Apply ISEF Filter in Y direction
3	Apply Binary Laplacian Technique
4	Apply Non Maxima Suppression
5	Find the Gradient
6	Apply Hysteresis Thresholding

Shen Castan Infinite Symmetric Exponential Filter is an optimal edge detector. First the whole image will be filtered by the recursive ISEF filter in X and Y direction respectively which can be implemented by using following equations:

Recursion in x direction:

$$y_1[i,j] = \frac{(1-b)}{(1+b)} I[i,j] + b\, y_1[i,j-1],\ j = 1...N, i = 1..M \quad \ldots\ldots(1)$$

$$y_2[i,j] = b\frac{(1-b)}{(1+b)} I[i,j] + b\, y_1[i,j+1],\ j = N...1, i = 1..M \quad \cdots(2)$$

$$r[i,j] = y_1[i,j] + y_2[i,j+1] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Recursion in y direction

$$y_1[i,j]=\frac{(1-b)}{(1+b)}\, I[i,j]+b\, y_1[i-1,j], i=1...M,\ j=1..N \ldots\ldots(1)$$

$$y_2[i,j]=b\frac{(1-b)}{(1+b)}\, I[i,j]+b\, y_1[i+1,j], i=M...1,\ j=1..N \ldots(2)$$

$$y[i,j]=y_1[i,j]+y_2[i+1,j] \ldots\ldots\ldots(3)$$

b=thinning factor (0<b<1)

Subtract the filtered image from the original image to obtain the Laplacian image. In the filtered image, there will be zero crossing in the second derivative at the location of an edge pixel because the first derivative of the image function should have an extreme at the position corresponding to the edge in image. Non maxima suppression is used for thinning purpose for false zero crossing. The gradient is either a maximum or a minimum at the edge pixel. If the second derivative changes sign from positive to negative, it is known as positive zero crossing and if it changes sign from negative to positive, it is known as negative zero crossing. We will permit positive zero crossing to have positive gradient and negative zero crossing to have negative gradient. We considered all other zero crossing as false zero crossing. Thresholding is applied on gradient image. One cutoff is used in simple thresholding but Shen-Castan suggests for Hysteresis thresholding in which two cut offs are used. Thresholding is applied on the output of an edge detector to decide significant edges. Noise will create spurious response to the single edge that will create a streaking problem. Streaking is defined by breaking up of the edge contour caused by the operator fluctuating above and below the threshold.

Hysteresis thresholding is used to eliminate streaking problem. Individual weak responses usually correspond to noise, but if these points are connected to any of the pixels with strong responses, they are more likely to be actual edge in the image. Such connected pixels are treated as edge pixels if their response is above a low threshold. The ISEF algorithm is given in table II. Output is shown in figure 4.

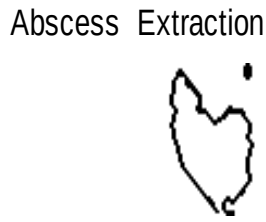

Figure 4: Abscess Extracted using ISEF(LT=0.5 HT=0.7)

IV. RESULTS AND DISCUSSION

After converting the dental radiograph to gray scale image, we apply adaptive histogram equalization to original image. Then we apply median filter to remove noise in it.

Now we convert noise free adaptive histogram equalized image in to binary image. We extract abscess present area using image cropping operation

Edge detection of abscess is done using ISEF as shown in figure 4.

The same approach is applied on various dental radiograph and the result is shown in figure 5.

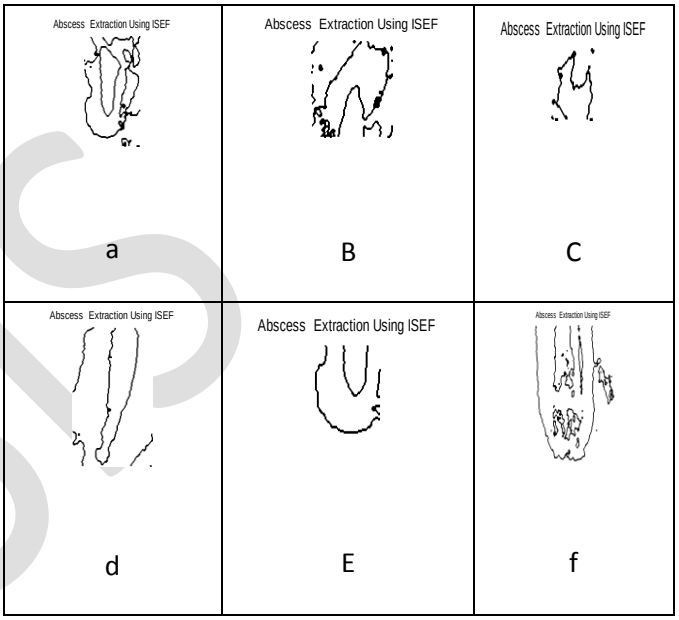

Figure 5: Results of various dental radiograph of various patients for detection of abscess

V. CONCLUSION

Figure 5 are the resultant images which were also shown to various dentists and the results were not only accurate but well appreciated and recommended for further research. Figure 5 is the edge detected dental radiograph of patients which gives a clear idea of the abscess. The decision so taken were easy and clear as the dental radiograph edge detected images were noise free as well as clear lines depicted the abscess.

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